

Cambridge IGCSE™

COMBINED SCIENCE**0653/41**

Paper 4 Theory (Extended)

May/June 2024**MARK SCHEME**Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

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Question	Answer	Marks
1(a)	ventricle ; pulmonary ; lungs ; closes / shuts ;	4
1(b)(i)	120 – 160 beats per minute (ticked) ;	1
1(b)(ii)	decreases (with age) ;	1
1(b)(iii)	<i>any three from:</i> muscles require more energy (for contraction) ; more oxygen (and glucose) transported (to muscle) ; reference to increases (rate of) respiration ; remove more carbon dioxide (from lungs) / increased carbon dioxide in the, blood / muscle / more carbon dioxide released (from respiration) ;	3

Question	Answer	Marks
2(a)	A (cold) water (out) (at top) B condenser C (cold) water (in) (at bottom of condenser) D heat/(Bunsen) burner E salt and water / mixture / solution ;;; <i>5 correct = (3) 3–4 correct = (2) 1–2 correct = (1)</i>	3
2(b)	heat (the solution) ; to remove the water ;	2

Question	Answer	Marks
2(c)	6 Na and 6 Cl ; alternating Na ⁺ and Cl ⁻ both horizontally and vertically ;	2
2(d)	sodium (atom) loses an / one electron (to give +1 charge) OR sodium (ion) has one electron fewer than the proton number ; chlorine (atom) gains an / one electron (to give –1 charge) OR chloride (ion) has one electron more than the proton number ;	2

Question	Answer	Marks
3(a)(i)	convection ;	1
3(a)(ii)	<i>any two from:</i> water expands on heating ; density decreases ; warmer / lower density, water rises ;	2
3(b)(i)	boiling ;	1
3(b)(ii)	in the air / vapour (above the boiling water) ;	1
3(c)(i)	drawing of lower part of thermometer at an angle to the upper part AND angle bent shallower, but still below horizontal ;	1
3(c)(ii)	$3 \times 10^8 \text{ m / s}$ / $3 \times 10^5 \text{ km / s}$;	1
3(c)(iii)	infrared / microwave / radio ;	1
3(c)(iv)	<u>speed</u> (of light) increases ;	1

Question	Answer	Marks
4(a)	B ; E ;	2
4(b)(i)	<i>any two from:</i> energy store ; jelly coating OR a coating that changes after fertilisation ; AVP ;	2
4(b)(ii)	<i>any two from:</i> have a cell membrane ; contain cytoplasm ; have a nucleus ;	2
4(c)(i)	protect from mechanical shock ;	1
4(c)(ii)	idea that placenta, obtains / exchanges / passes / diffuses nutrients from mother (’s blood) ; idea that the umbilical cord, passes / transports, nutrients / glucose / oxygen (to fetus) ;	2

Question	Answer	Marks
5(a)(i)	activation energy shown as a maximum between reactants and products ; activation energy labelled correctly ; energy change of reaction labelled with upwards arrow ;	3
5(a)(ii)	products are at a higher energy level than reactants / products have more energy than reactants / ORA ;	1
5(a)(iii)	$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g}) ; ;$ <i>correctly balanced equation = (1)</i> <i>state symbols (g) (g) (g) = (1)</i>	2

Question	Answer	Marks
5(b)	buildings: the idea of (chemical) reaction with, metal / building materials ; health: adverse effect on, heart / lungs / breathing ;	2

Question	Answer	Marks
6(a)(i)	unit mass / 1 kg ;	1
6(a)(ii)	(resultant force) = 15000 – 14750 (= 250 N) ;	1
6(b)(i)	5.0 (m / s) ;	1
6(b)(ii)	$a = v \div t$ / evidence of use of formula ; = 0.20 ; m / s ² ;	3
6(b)(iii)	use of area under graph seen, i.e. $\frac{1}{2} \times 25 \times 5$; (= 62.5 m)	1
6(b)(iv)	(increase in KE =) $\frac{1}{2}mv^2$ OR $\frac{1}{2} \times 1475 \times 5 \times 5$ OR 18437.5 ; (increase in PE =) mgh OR $1475 \times 10 \times 62.5$ OR 921875 ; <u>18437.5 AND 921875</u> ; 940 000 (J) ;	4

Question	Answer	Marks
7(a)(i)	P photosynthesis ; Q gas exchange ;	2
7(a)(ii)	gradient and atmosphere ; diffusion ; decrease ;	3
7(b)(i)	one / 1 ;	1
7(b)(ii)	<i>any three from:</i> vulture is on trophic level 5 ; energy is lost at each trophic level ; named example of energy lost, e.g., heat / respiration / excretion / protein synthesis / metabolism / not all organism is eaten ; not enough energy (for quaternary consumer) ;	3

Question	Answer	Marks
8(a)(i)	cracking ;	1
8(a)(ii)	<i>any two from:</i> high temperature ; high pressure ; catalyst ;	2
8(b)(i)	<i>similarity:</i> both, have two carbon atoms / are hydrocarbons / contain carbon and hydrogen only / both are covalent / both are simple molecules ; <i>differences (any two from):</i> ethane has (two) more hydrogen atoms / 6 hydrogen not 4 ; ethene / alkene, has a (carbon to carbon) double bond and ethane / alkane, has only (carbon to carbon) single bonds ; ethene / alkene, is unsaturated and ethane / alkane, is saturated ;	3

Question	Answer	Marks
8(b)(ii)	$2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$; ; <i>CO₂ and H₂O as products = (1)</i>	2
8(c)	five / 5 ;	1

Question	Answer	Marks
9(a)	F ; J ;	2
9(b)	correct symbol for voltmeter ; connected in parallel with lamps ;	2
9(c)(i)	(difference between e.m.f. and p.d. across lamps = $5.5 - 3.0 =$) 2.5 (V) ;	1
9(c)(ii)	($R =$) $V \div I$ in any form OR 0.3 seen OR $3.0 \div 0.6$ OR 5(.0) ; 10 (Ω) ;	2

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Question	Answer			Marks												
1(a)	<table><tr><td>label</td><td>name of part</td><td>function</td></tr><tr><td>B</td><td>(stomach)</td><td>(digestion of protein)</td></tr><tr><td>(E)</td><td>small intestine</td><td>(digestion of insoluble molecules and) absorption (of soluble molecules)</td></tr><tr><td>(C)</td><td>pancreas</td><td>(secretion of lipase)</td></tr></table> one mark for each correct row			label	name of part	function	B	(stomach)	(digestion of protein)	(E)	small intestine	(digestion of insoluble molecules and) absorption (of soluble molecules)	(C)	pancreas	(secretion of lipase)	3
label	name of part	function														
B	(stomach)	(digestion of protein)														
(E)	small intestine	(digestion of insoluble molecules and) absorption (of soluble molecules)														
(C)	pancreas	(secretion of lipase)														
1(b)	small(er) ; mechanical ; chemical ; amino acids ;			4												
1(c)	any three from: lipase activity between pH6–pH12 / lipase inactive below pH6 / lipase inactive in acidic conditions / stomach pH low / stomach is (very) acidic / stomach pH from 1.5 to 3.5 ; (so) lipase would denature (in stomach) ; active site, changes shape / is no longer complementary (to the substrate) ; lipase is unable to, bind to / fit, substrate ;			3												

Question	Answer	Marks
2(a)	separation process crystallisation filtration chromatography description separating an insoluble solid from a mixture of a solid in water separating dyes from a mixture of dyes in a coloured ink separating a salt from an aqueous solution <i>all three correct = (2) one or two correct = (1)</i>	2
2(b)	water, boils / is heated and evaporates / becomes steam / becomes water vapour / leaves the flask ; steam / vapour / it is, cooled in the condenser OR steam / vapour / it, condenses ; salt is left behind / salt does not evaporate (with the water) / only water evaporates ;	3
2(c)(i)	<i>any two from:</i> is ionic / has ionic bonds ; strong attraction / force, between ions (in ionic lattice) ; due to opposite charges / ions have opposite charges ; need lots of energy to, break bonds / separate the ions / separate the particles (therefore high mp) ;	2

Question	Answer	Marks
2(c)(ii)	energy is needed to, change state / make particles move (more) ; more energy needed to, overcome forces between / separate particles when, changing from liquid to gas than from solid to liquid ;	2
2(c)(iii)	particles in solid (-10°C) in regular arrangement, consistent size and touching ; fewer particles in gas ($+110^{\circ}\text{C}$), consistent size and not touching ;	2

Question	Answer	Marks
3(a)	chemical ; thermal ;	2
3(b)	air (above flame) is heated ; less dense air rises ;	2
3(c)(i)	number of wavelengths, per <u>unit</u> time / per second ;	1
3(c)(ii)	microwaves / radio waves ;	1
3(c)(iii)	$(\lambda =) v \div f$ or $3.0 \times 10^8 \div 0.95 \times 10^{14}$; $3.2 (3.16) \times 10^{-6} \text{ (m)}$;	2

Question	Answer	Marks
4(a)(i)	vacuole and cytoplasm circled ;	1
4(a)(ii)	large surface area / elongated shape ; increases, rate of absorption / uptake of water / uptake of mineral (ions) ;	2

Question	Answer	Marks
4(b)(i)	(as light intensity increases) rate of photosynthesis increases, and then levels off / is constant ;	1
4(b)(ii)	more light / less competition for light ; more CO ₂ / less competition for CO ₂ / CO ₂ is released by combustion ;	2
4(c)	magnesium is required to make chlorophyll ; chlorophyll is a green pigment ;	2

Question	Answer	Marks
5(a)	(overall) energy change is endothermic or more energy taken in than given out ; and either bond breaking is endothermic / energy is taken in to break bonds or bonds forming is exothermic / energy is given out when bonds form ;	2
5(b)(i)	$2\text{NO(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{NO}_2\text{(g)} ; ;$ <i>correctly balanced equation = (1)</i> <i>state symbols (g) (g) (g) = (1)</i>	2
5(b)(ii)	reactants higher than products and maximum shown ; activation energy and up-arrow and energy change of reaction and down-arrow ;	2

Question	Answer	Marks
6(a)(i)	max. speed = 0.010 m/s OR 3600 OR 1000 ; both conversions seen 3600 (s) and 1000 (m) and correct substitution ;	2
6(a)(ii)	($a =$) $\Delta v \div t$ or $0.005 \div 50$; $0.0001(0) / 1 \times 10^{-4}$; m/s^2 ;	3
6(a)(iii)	acceleration ; acceleration is not constant ;	2
6(b)(i)	$\text{KE} = \frac{1}{2} mv^2$ (<i>in any form</i>) or $\frac{1}{2} \times 890 \times 0.05 \times 0.05$; $= 1.1125$; (≈ 1.1)	2
6(b)(ii)	GPE (gained) = 1.1 J ; (GPE =) mgh or $890 \times 3.8 \times h$ or $h = 1.1 \div (890 \times 3.8)$; 0.33 mm ;	3

Question	Answer	Marks
7(a)(i)	X pulmonary vein ; Y aorta ;	2
7(a)(ii)	septum labelled ;	1
7(a)(iii)	separates blood with and without oxygen ; blood to lungs at lower pressure or blood to body at higher pressure ;	2

Question	Answer	Marks
7(b)(i)	any two from: large surface / large area ; thin (surface) ; good blood supply ; good ventilation ; AVP, e.g. moist ;	2
7(b)(ii)	Carbon dioxide is a product of respiration. ; Water evaporates from the lining of the alveoli. ; <i>three ticks and two correct = 1 mark</i> <i>three ticks and one correct = 0 marks</i> <i>more than three ticks = 0 marks</i>	2

Question	Answer	Marks
8(a)	hydrogen / H ₂ ; magnesium oxide / MgO / magnesium hydroxide / Mg(OH) ₂ ; hydrochloric acid / HCl ; carbon dioxide AND water / CO ₂ AND H ₂ O ;	4
8(b)(i)	sulfuric acid / hydrochloric acid ;	1
8(b)(ii)	water ;	1

Question	Answer	Marks
8(c)	any three from: magnesium is in Group II ; magnesium has two electrons in the outer shell ; metals are on left of the Periodic Table ; metals have, low / 1–3, electrons in the outer shells ;	3

Question	Answer	Marks
9(a)	a.c. power supply ;	1
9(b)(i)	$(R =) V \div I$ in any form or $240 \div 25$; 9.6 (A) ;	2
9(b)(ii)	$(P =) V \times I$ in any form or 240×9.6 ; 2300 (W) / 2.3 kW ;	2
9(c)	lamp symbol connected in parallel with heater ; lamp symbol in parallel and connected to left of heater and to the left of the heater's switch ;	2

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1(a)(i)		label	name	function
		A	(sepal)	to protect / to support (the flower / bud / ovary)
		(C)	anther	(produces) pollen / male gamete
		D	stigma	(site of pollination)
	one mark for each correct row			3
1(a)(ii)	any one from: (large) petals ; anther inside (petals / flower) ; stigma inside (petals / flower) ;			1
1(b)(i)	any two from: flagellum ; enzymes ; AVP ;			2
1(b)(ii)	(nucleus of sperm cell) fuses / joins ; with <u>nucleus</u> of, ovum / egg ;			2

Question	Answer	Marks
2(a)(i)	activation energy correctly labelled on both diagrams ; energy change of reaction shown by upward arrow for first diagram ; energy change of reaction shown by downward arrow for second diagram ;	3

Question	Answer	Marks										
2(a)(ii)	<table><tr><td>true</td><td>false</td></tr><tr><td></td><td>✓</td></tr><tr><td>✓</td><td></td></tr><tr><td>✓</td><td></td></tr><tr><td></td><td>✓</td></tr></table> <i>All correct = 2 marks</i> <i>2 to 3 correct = 1 mark</i>	true	false		✓	✓		✓			✓	2
true	false											
	✓											
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	✓											
2(a)(iii)	$2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$;	1										
2(b)	weak forces between molecules / weak inter molecular forces ; need low amounts of energy to change from liquid to gas / low amount of energy to, separate molecules / overcome / break the force ;	2										

Question	Answer							Marks							
3(a)(i)	<table><tr><td>gamma radiation</td><td></td><td>ultraviolet</td><td></td><td></td><td>microwaves ;</td><td>radio waves</td></tr></table>							gamma radiation		ultraviolet			microwaves ;	radio waves	1
gamma radiation		ultraviolet			microwaves ;	radio waves									
3(a)(ii)	sunburn / skin cancer / skin damage / eye damage ;							1							
3(b)(i)	speed = distance ÷ time <i>in any form</i> OR $37\,000 \div 3.0 \times 10^5$; $12(.3) \times 10^{-2}$ OR 0.12 (s) ;							2							

Question	Answer	Marks
3(b)(ii)	conversion km to m seen ; $v = f\lambda$ in any form / $3 \times 10^8 \div 12 \times 10^9$; 0.025 (m) ;	3

Question	Answer	Marks
4(a)(i)	pancreas labelled ;	1
4(a)(ii)	amylase breaks down or digests, starch / carbohydrate, or amylase has an active site complementary to starch ; protein (shape), is not complementary to / will not fit <u>active site</u> ;	2
4(a)(iii)	amino acids ;	1
4(b)(i)	lack of sunlight ;	1
4(b)(ii)	soft, bones / teeth ;	1
4(b)(iii)	thin walls / permeable walls / short diffusion distance ; to allow exchange of material / to allow substances to, diffuse / pass through the walls (between cells and blood) ;	2

Question	Answer	Marks
5(a)(i)	zinc sulfate ; zinc oxide / zinc hydroxide ;	2
5(a)(ii)	hydrogen ; water ;	2
5(b)	carbon dioxide ; water ;	2

Question	Answer	Marks
5(c)	full range / universal, indicator ; compare (colours) with chart / colour corresponds to a number ;	2
5(d)	add, calcium carbonate / limestone / calcium hydroxide / (slaked) lime / add a base ;	1
6(a)(i)	arrow pointing to right, touching bus and same length as arrow Q ;	1
6(a)(ii)	friction / air resistance ;	1
6(b)	force P = 75000 N or weight of bus = 75000 N ; no vertical motion / arrow R is same length as arrow P / no resultant force / R and P are balanced forces ;	2
6(c)(i)	acceleration = initial slope of graph OR 12 / 100 ; 0.12 ; m / s ² ;	3
6(c)(ii)	distance while accelerating = $\frac{1}{2} 100 \times 12$ OR 600 (m) ; distance at constant speed = 150×12 OR 1800 (m) ; total distance = (1800 + 600) = 2400 (m) ;	3
6(c)(iii)	(distance = 2650 – 2400 =) 250 (m) ;	1

Question	Answer	Marks
7(a)(i)	both / they, transport (substances) ; and either xylem / X , also provides support / transports mineral ions / transports up the stem ; or phloem / Y , transports sugars / amino acids / transports up and down the stem ;	2

Question	Answer	Marks
7(a)(ii)	by evaporation (from the surface) ; water vapour moves to / out of, stomata ; (water vapour passes through stomata) by diffusion ;	3
7(b)	tip ; elongation ; gravity and light ;	3
7(c)(i)	small fish and clam ;	1
7(c)(ii)	tertiary carnivore large ;; <i>all correct = 2 marks</i> <i>two correct = 1 mark</i>	2

Question	Answer	Marks
8(a)(i)	they all have similar chemical properties / all contain a (carbon-carbon) double bond ;	1
8(a)(ii)	alkenes: C_nH_{2n} ; alkanes: C_nH_{2n+2} ;	2
8(b)	six carbon atoms bonded in a row (bonded with hydrogen atoms) ; 6 C and no double bonds and 12 H correctly bonded and continuation lines shown ;	2

Question	Answer	Marks
8(c)(i)	4 C atoms and 10 H atoms bonded in a row ; correct butane structure drawn to show single bonds ;	2
8(c)(ii)	any two from: high temperature ; high pressure ; catalyst ;	2

Question	Answer	Marks
9(a)	volts ; electrons / charge ;	2
9(b)(i)	power = $V \times I$ or 2.4×0.50 ; 1.2 (W) ;	2
9(b)(ii)	$Q = It$ or $9000 = 0.5 \times t$ or $(t =) 9000 \div 0.5$; (time = $9000 \div 0.5$) = 18000 s ; seconds to hours = 5(.0) h ;	3
9(c)(i)	lamps in parallel (instead of in series) ;	1
9(c)(ii)	greater (<i>no mark</i>) (reason) less resistance or current from source / total current, is sum of (separate) currents in, each lamp / each branch ;	1